

SPECIFICATION: ELECTRICAL SITE PREP

Project #595-12-111

Lebanon VA Medical Center

5-25-2012

TABLE OF CONTENTS:

07 92 00	JOINT SEALANTS
26 05 11	REQUIREMENTS FOR ELECTRICAL INSTALLATION
26 05 26	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
26 05 33	RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS
26 05 41	UNDERGROUND ELECTRICAL CONSTRUCTION
31 20 00	EARTHMOVING

SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. Section covers all sealant and caulking materials and their application, wherever required for complete installation of building materials or systems.
- B.

1.2 QUALITY CONTROL:

- A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. VOC: Acrylic latex and Silicon sealants shall have less than 50g/l VOC content.
- D. Mockups: Before installing joint sealants, apply elastomeric sealants as follows to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution:
 - 1. Joints in mockups of assemblies specified in other Sections that are indicated to receive elastomeric joint sealants, which are specified by reference to this section.

1.3 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's installation instructions for each product used.
- C. Cured samples of exposed sealants for each color where required to match adjacent material.
- D. Manufacturer's Literature and Data:
 - 1. Caulking compound
 - 2. Primers
 - 3. Sealing compound, each type, including compatibility when different sealants are in contact with each other.

1.4 PROJECT CONDITIONS:

- A. Environmental Limitations:
 - 1. Do not proceed with installation of joint sealants under following conditions:
 - a. When ambient and substrate temperature conditions are outside limits

permitted by joint sealant manufacturer or are below 4.4° C (40° F).

b. When joint substrates are wet.

B. Joint-Width Conditions:

1. Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

C. Joint-Substrate Conditions:

1. Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.5 DELIVERY, HANDLING, AND STORAGE:

- A. Deliver materials in manufacturers' original unopened containers, with brand names, date of manufacture, shelf life, and material designation clearly marked thereon.
- B. Carefully handle and store to prevent inclusion of foreign materials.
- C. Do not subject to sustained temperatures exceeding 32° C (90° F) or less than 5° C (40° F).

1.6 DEFINITIONS:

- A. Definitions of terms in accordance with ASTM C717 and as specified.
- B. Back-up Rod: A type of sealant backing.
- C. Bond Breakers: A type of sealant backing.
- D. Filler: A sealant backing used behind a back-up rod.

1.7 WARRANTY:

- A. Warranty exterior sealing against leaks, adhesion, and cohesive failure, and subject to terms of "Warranty of Construction", FAR clause 52.246-21, except that warranty period shall be extended to two years.
- B. General Warranty: Special warranty specified in this Article shall not deprive Government of other rights Government may have under other provisions of Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of Contract Documents.

1.8 APPLICABLE PUBLICATIONS:

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Society for Testing and Materials (ASTM):
 1. C509-06 Elastomeric Cellular Preformed Gasket and Sealing Material.
 2. C612-10 Mineral Fiber Block and Board Thermal Insulation.
 3. C717-10 Standard Terminology of Building Seals and Sealants.
 4. C834-10 Latex Sealants.
 5. C919-08. Use of Sealants in Acoustical Applications.

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6. C920-10 Elastomeric Joint Sealants.
 7. C1021-08 Laboratories Engaged in Testing of Building Sealants.
 8. C1193-09 Standard Guide for Use of Joint Sealants.
 9. C1330-02 (R2007) Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants.
 10. D1056-07 Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
 11. E84-09 Surface Burning Characteristics of Building Materials.
- C. Sealant, Waterproofing and Restoration Institute (SWRI).
[The Professionals' Guide](#)

PART 2 - PRODUCTS

2.1 SEALANTS:

- A. S-1:
1. ASTM C920, polyurethane or polysulfide.
 2. Type M.
 3. Class 25.
 4. Grade NS.
 5. Shore A hardness of 20-40
- B. S-4:
1. ASTM C920 polyurethane or polysulfide.
 2. Type S.
 3. Class 25.
 4. Grade NS.
 5. Shore A hardness of 25-40.
- C. S-6:
1. ASTM C920, silicone, neutral cure.
 2. Type S.
 3. Class: Joint movement range of plus 100 percent to minus 50 percent.
 4. Grade NS.
 5. Shore A hardness of 15-20.
 6. Minimum elongation of 1200 percent.
- D. S-7:
1. ASTM C920, silicone, neutral cure.
 2. Type S.
 3. Class 25.
 4. Grade NS.
 5. Shore A hardness of 25-30.

6. Structural glazing application.

E. S-9:

1. ASTM C920 silicone.
2. Type S.
3. Class 25.
4. Grade NS.
5. Shore A hardness of 25-30.
6. Non-yellowing, mildew resistant.

2.2 CAULKING COMPOUND:

- A. C-1: ASTM C834, acrylic latex.
- B. C-2: One component acoustical caulking, non drying, non hardening, synthetic rubber.

2.3 COLOR:

- A. Sealants used with exposed masonry shall match color of mortar joints.
- B. Sealants used with unpainted concrete shall match color of adjacent concrete.
- C. Color of sealants for other locations shall be light gray or aluminum, unless specified otherwise.
- D. Caulking shall be light gray or white, unless specified otherwise.

2.4 JOINT SEALANT BACKING:

- A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
 1. Type C: Closed-cell material with a surface skin.
- C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 32° C (minus 26° F). Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.
- D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self- adhesive tape where applicable.

2.5 FILLER:

- A. Mineral fiber board: ASTM C612, Class 1.

- B. Thickness same as joint width.
- C. Depth to fill void completely behind back-up rod.

2.6 PRIMER:

- A. As recommended by manufacturer of caulking or sealant material.
- B. Stain free type.

2.7 CLEANERS-NON POUROUS SURFACES:

- A. Chemical cleaners acceptable to manufacturer of sealants and sealant backing material, free of oily residues and other substances capable of staining or harming joint substrates and adjacent non-porous surfaces and formulated to promote adhesion of sealant and substrates.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Inspect substrate surface for bond breaker contamination and unsound materials at adherent faces of sealant.
- B. Coordinate for repair and resolution of unsound substrate materials.
- C. Inspect for uniform joint widths and that dimensions are within tolerance established by sealant manufacturer.

3.2 PREPARATIONS:

- A. Prepare joints in accordance with manufacturer's instructions and SWRI.
- B. Clean surfaces of joint to receive caulking or sealants leaving joint dry to the touch, free from frost, moisture, grease, oil, wax, lacquer paint, or other foreign matter that would tend to destroy or impair adhesion.
 - 1. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants.
 - 2. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.

- C. Do not cut or damage joint edges.
- D. Apply masking tape to face of surfaces adjacent to joints before applying primers, caulking, or sealing compounds.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- E. Apply primer to sides of joints wherever required by compound manufacturer's printed instructions.
 - 1. Apply primer prior to installation of back-up rod or bond breaker tape.
 - 2. Use brush or other approved means that will reach all parts of joints.
- F. Take all necessary steps to prevent three sided adhesion of sealants.

3.3 BACKING INSTALLATION:

- A. Install back-up material, to form joints enclosed on three sides as required for specified depth of sealant.
- B. Where deep joints occur, install filler to fill space behind the back-up rod and position the rod at proper depth.
- C. Cut fillers installed by others to proper depth for installation of back-up rod and sealants.
- D. Install back-up rod, without puncturing the material, to a uniform depth, within plus or minus 3 mm (1/8 inch) for sealant depths specified.
- E. Where space for back-up rod does not exist, install bond breaker tape strip at bottom (or back) of joint so sealant bonds only to two opposing surfaces.
- F. Take all necessary steps to prevent three sided adhesion of sealants.

3.4 SEALANT DEPTHS AND GEOMETRY:

- A. At widths up to 6 mm (1/4 inch), sealant depth equal to width.
- B. At widths over 6 mm (1/4 inch), sealant depth 1/2 of width up to 13 mm (1/2 inch) maximum depth at center of joint with sealant thickness at center of joint approximately 1/2 of depth at adhesion surface.

3.5 INSTALLATION:

- A. General:
 - 1. Apply sealants and caulking only when ambient temperature is between 5° C and 38° C (40° F and 100° F).
 - 2. Do not use polysulfide base sealants where sealant may be exposed to fumes from bituminous materials, or where water vapor in continuous contact with cementitious materials may be present.
 - 3. Do not use sealant type listed by manufacture as not suitable for use in locations specified.
 - 4. Apply caulking and sealing compound in accordance with manufacturer's printed instructions.
 - 5. Avoid dropping or smearing compound on adjacent surfaces.

6. Fill joints solidly with compound and finish compound smooth.
 7. Tool joints to concave surface unless shown or specified otherwise.
 8. Finish paving or floor joints flush unless joint is otherwise detailed.
 9. Apply compounds with nozzle size to fit joint width.
 10. Test sealants for compatibility with each other and substrate. Use only compatible sealant.
- B. For application of sealants, follow requirements of ASTM C1193 unless specified otherwise.
- C. Where gypsum board partitions are of sound rated, fire rated, or smoke barrier construction, follow requirements of ASTM C919 only to seal all cut-outs and intersections with the adjoining construction unless specified otherwise.
1. Apply a 6 mm (1/4 inch) minimum bead of sealant each side of runners (tracks), including those used at partition intersections with dissimilar wall construction.
 2. Coordinate with application of gypsum board to install sealant immediately prior to application of gypsum board.
 3. Partition intersections: Seal edges of face layer of gypsum board abutting intersecting partitions, before taping and finishing or application of veneer plaster-joint reinforcing.
 4. Openings: Apply a 6 mm (1/4 inch) bead of sealant around all cut-outs to seal openings of electrical boxes, ducts, pipes and similar penetrations. To seal electrical boxes, seal sides and backs.
 5. Control Joints: Before control joints are installed, apply sealant in back of control joint to reduce flanking path for sound through control joint.

3.6 FIELD QUALITY CONTROL:

- A. Field-Adhesion Testing: Field-test joint-sealant adhesion to joint substrates as recommended by sealant manufacturer:
1. Extent of Testing: Test completed elastomeric sealant joints as follows:
 - a. Perform 10 tests for first 300 m (1000 feet) of joint length for each type of elastomeric sealant and joint substrate.
 - b. Perform one test for each 300 m (1000 feet) of joint length thereafter or one test per each floor per elevation.
- B. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field adhesion test log.
- C. Inspect tested joints and report on following:
1. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate.
 2. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
 3. Whether sealants filled joint cavities and are free from voids.

4. Whether sealant dimensions and configurations comply with specified requirements.

- D. Record test results in a field adhesion test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
- E. Repair sealants pulled from test area by applying new sealants following same procedures used to originally seal joints. Ensure that original sealant surfaces are clean and new sealant contacts original sealant.
- F. Evaluation of Field-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements, will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.7 CLEANING:

- A. Fresh compound accidentally smeared on adjoining surfaces: Scrape off immediately and rub clean with a solvent as recommended by the caulking or sealant manufacturer.
- B. After filling and finishing joints, remove masking tape.
- C. Leave adjacent surfaces in a clean and unstained condition.

3.8 LOCATIONS:

- A. Exterior Building Joints, Horizontal and Vertical:
 - 1. Metal to Masonry or Stone: Type S-1
 - 2. Masonry to Masonry or Stone: Type S-1
 - 3. Stone to Stone: Type S-1
 - 4. Cast Stone to Cast Stone: Type S-1
 - 5. Threshold Setting Bed: Type S-1, S-4
 - 6. Masonry Expansion and Control Joints: Type S-6
- B. Metal Reglets and Flashings:
 - 1. Flashings to Wall: Type S-6
 - 2. Metal to Metal: Type S-6
- C. Sanitary Joints:
 - 1. Walls to Plumbing Fixtures: Type S-9
 - 2. Counter Tops to Walls: Type S-9
 - 3. Pipe Penetrations: Type S-9
- D. High Temperature Joints over 204 degrees C (400 degrees F):
 - 1. Exhaust Pipes, Flues, Breech Stacks: Type S-7
- E. Interior Caulking:
 - 1. Typical Narrow Joint 6 mm, (1/4 inch) or less at Walls and Adjacent Components: Types C-1 and C-2.

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2. Perimeter of Doors, Windows, Access Panels which Adjoin Concrete or Masonry Surfaces: Types C-1, C-2.
3. Joints at Masonry Walls and Columns, Piers, Concrete Walls or Exterior Walls: Types C-1 and C-2.
4. Exposed Isolation Joints at Top of Full Height Walls: Types C-1 and C-2.
5. Exposed Acoustical Joint at Sound Rated Partitions Type C-2.
6. Concealed Acoustic Sealant Types S-4, C-1 and C-2.

- - - E N D - - -

SECTION 26 05 11
REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section applies to all sections of Division 26.
- B. Furnish and install electrical wiring, systems, equipment and accessories in accordance with the specifications and drawings. Capacities and ratings electrical items and arrangements for the specified items are shown on drawings.
- C. Wiring ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways accordingly sized. Aluminum conductors are prohibited.

1.2 MINIMUM REQUIREMENTS

- A. References to the International Building Code (IBC), National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL) and National Fire Protection Association (NFPA) are minimum installation requirement standards.
- B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

1.3 TEST STANDARDS

- A. All materials and equipment shall be listed, labeled or certified by a nationally recognized testing laboratory to meet Underwriters Laboratories, Inc., standards where test standards have been established. Equipment and materials which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA, or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.
- B. Definitions:
 - 1. Listed; Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production or listed equipment or materials or periodic evaluation of services, and whose listing states that the equipment, material, or services either meets

- appropriate designated standards or has been tested and found suitable for a specified purpose.
2. Labeled; Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.
 3. Certified; equipment or product which:
 - a. Has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
 - b. Production of equipment or product is periodically inspected by a nationally recognized testing laboratory.
 - c. Bears a label, tag, or other record of certification.
 4. Nationally recognized testing laboratory; laboratory which is approved, in accordance with OSHA regulations, by the Secretary of Labor.

1.4 QUALIFICATIONS (PRODUCTS AND SERVICES)

- A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- B. Product Qualification:
 1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
 2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within eight hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.5 APPLICABLE PUBLICATIONS

Applicable publications listed in all Sections of Division are the latest issue, unless otherwise noted.

1.6 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.
- B. When more than one unit of the same class or type of equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
 - 1. Components of an assembled unit need not be products of the same manufacturer.
 - 2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
 - 3. Components shall be compatible with each other and with the total assembly for the intended service.
 - 4. Constituent parts which are similar shall be the product of a single manufacturer.

1.7 EQUIPMENT PROTECTION

- A. Equipment and materials shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.
 - 1. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Equipment shall include but not be limited to cables, wire, and accessories.
 - 2. During installation, equipment shall be protected against entry of foreign matter; and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.
 - 3. Damaged equipment shall be, as determined by the Resident Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
 - 4. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
 - 5. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.8 WORK PERFORMANCE

- A. All electrical work must comply with the requirements of NFPA 70 (NEC), NFPA 70B, NFPA 70E, OSHA Part 1910 subpart J, OSHA Part 1910 subpart S

and OSHA Part 1910 subpart K in addition to other references required by contract.

- B. Job site safety and worker safety is the responsibility of the contractor.
- C. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished in this manner for the required work, the following requirements are mandatory:
 - 1. Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.
 - 2. Electricians must wear personal protective equipment while working on energized systems in accordance with NFPA 70E.
 - 3. Before initiating any work, a job specific work plan must be developed by the contractor with a peer review conducted and documented by the Resident Engineer and Medical Center staff. The work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used and exit pathways.
 - 4. Work on energized circuits or equipment cannot begin until prior written approval is obtained from the Resident Engineer.
- D. For work on existing stations, arrange, phase and perform work to assure electrical service for other buildings at all times.
- E. New work shall be installed and connected to existing work neatly, safely and professionally. Disturbed or damaged work shall be replaced or repaired to its prior conditions.
- F. Coordinate location of equipment and conduit with other trades to minimize interferences.

1.9 EQUIPMENT INSTALLATION AND REQUIREMENTS

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Working spaces shall not be less than specified in the NEC for all voltages specified.
- C. Inaccessible Equipment:
 - 1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.

2. "Conveniently accessible" is defined as being capable of being reached quickly for operation, maintenance, or inspections without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

1.10 EQUIPMENT IDENTIFICATION

- A. In addition to the requirements of the NEC, install an identification sign which clearly indicates information required for use and maintenance.

1.11 SUBMITTALS

- A. Submit in accordance with VA guidelines and regulations.
- B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Government to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
 1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 3. Submit each section separately.
- E. The submittals shall include the following:
 1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
 2. Parts list which shall include those replacement parts recommended by the equipment manufacturer.
- F. Manuals: Submit in accordance with VA guidelines and regulations.
 1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the

- technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
 3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
 4. The manuals shall include:
 - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
 - b. A control sequence describing start-up, operation, and shutdown.
 - c. Description of the function of each principal item of equipment.
 - d. Installation instructions.
 - e. Safety precautions for operation and maintenance.
 - f. Diagrams and illustrations.
 - g. Periodic maintenance and testing procedures and frequencies, including replacement parts numbers and replacement frequencies.
 - h. Performance data.
 - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
 - j. List of factory approved or qualified permanent servicing organizations for equipment repair and periodic testing and maintenance, including addresses and factory certification qualifications.
- G. Approvals will be based on complete submission of manuals together with shop drawings.
- H. After approval and prior to installation, furnish the Resident Engineer with one sample of each of the following:
1. A 300 mm (12 inch) length of each type and size of wire and cable along with the tag from the coils of reels from which the samples were taken.
 2. Each type of conduit coupling, bushing and termination fitting.

3. Conduit hangers, clamps and supports.
4. Duct sealing compound.
5. Each type of receptacle, toggle switch, occupancy sensor, outlet box, manual motor starter, device wall plate, engraved nameplate, wire and cable splicing and terminating material, and branch circuit single pole molded case circuit breaker.

1.12 SINGULAR NUMBER

Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.13 ACCEPTANCE CHECKS AND TESTS

The contractor shall furnish the instruments, materials and labor for field tests.

1.14 TRAINING

- A. Training shall be provided in accordance with Article 1.25, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.
- B. Training shall be provided for the particular equipment or system as required in each associated specification.
- C. A training schedule shall be developed and submitted by the contractor and approved by the Resident Engineer at least 30 days prior to the planned training.

- - - E N D - - -

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the general grounding and bonding requirements for electrical equipment and operations to provide a low impedance path for possible ground fault currents.
- B. "Grounding electrode system" refers to all electrodes required by NEC, as well as made, supplementary grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this specification and have the same meaning.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
 - 1. Clearly present enough information to determine compliance with drawings and specifications.
 - 2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.
- C. Test Reports: Provide certified test reports of ground resistance.
- D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:
 - 1. Certification that the materials and installation are in accordance with the drawings and specifications.
 - 2. Certification by the contractor that the complete installation has been properly installed and tested.

1.5 APPLICABLE PUBLICATIONS

Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the

extent referenced. Publications are referenced in the text by designation only.

- A. American Society for Testing and Materials (ASTM):
- B1-07.....Standard Specification for Hard-Drawn Copper Wire
 - B3-07.....Standard Specification for Soft or Annealed Copper Wire
 - B8-04.....Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
- 81-1983.....IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
 - C2-07.....National Electrical Safety Code
- C. National Fire Protection Association (NFPA):
- 70-08.....National Electrical Code (NEC)
 - 99-2005.....Health Care Facilities
- D. Underwriters Laboratories, Inc. (UL):
- 44-05Thermoset-Insulated Wires and Cables
 - 83-08Thermoplastic-Insulated Wires and Cables
 - 467-07Grounding and Bonding Equipment
 - 486A-486B-03Wire Connectors

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

- A. Equipment grounding conductors shall be UL 44 or UL 83 insulated stranded copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG [25 mm²] and larger shall be identified per NEC.
- B. Bonding conductors shall be ASTM B8 bare stranded copper.
- C. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.

2.2 GROUND RODS

- A. Steel or copper clad steel, 0.75 in diameter by 10 ft long, conforming to UL 467.
- B. Quantity of rods shall be as required to obtain the specified ground resistance, as shown on the drawings.

2.3 GROUND CONNECTIONS

- A. Below Grade: Exothermic-welded type connectors.

PART 3 - EXECUTION

3.1 GENERAL

- A. Ground in accordance with the NEC, as shown on drawings, and as specified herein.
- B. Equipment Grounding: Metallic structures, including ductwork and building steel, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.

3.2 INACCESSIBLE GROUNDING CONNECTIONS

Make grounding connections, which are normally buried or otherwise inaccessible (except connections for which access for periodic testing is required), by exothermic weld.

3.3 CORROSION INHIBITORS

When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.4 GROUND RESISTANCE

- A. Grounding system resistance to ground shall not exceed 5 ohms. Make any modifications or additions to the grounding electrode system necessary for compliance without additional cost to the Government. Final tests shall ensure that this requirement is met.
- B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not fewer than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
- C. Below-grade connections shall be visually inspected by the Resident Engineer prior to backfilling. The contractor shall notify the Resident Engineer 24 hours before the connections are ready for inspection.

3.6 GROUND ROD INSTALLATION

- A. For outdoor installations, drive each rod vertically in the earth, until top of rod is 24 in below final grade.
- B. Where permanently concealed ground connections are required, make the connections by the exothermic process, to form solid metal joints. Make accessible ground connections with mechanical pressure-type ground connectors.
- C. Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

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SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes, to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise.
- B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

1.2 RELATED WORK

- A. Section 07 60 00, FLASHING AND SHEET METAL: Fabrications for the deflection of water away from the building envelope at penetrations.
- B. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- C. Section 07 92 00, JOINT SEALANTS: Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building.
- D. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- E. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- F. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Underground conduits.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. In addition to the requirements of Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
 - 1. Manufacturer's Literature and Data: Showing each cable type and rating. The specific item proposed and its area of application shall be identified on the catalog cuts.
 - 2. Shop Drawings:
 - a. Size and location of main feeders.
 - b. Size and location of panels and pull-boxes.
 - c. Layout of required conduit penetrations through structural elements.

3. Certifications:

- a. Two weeks prior to the final inspection, submit four copies of the following certifications to the COR:
 1. Certification by the manufacturer that the material conforms to the requirements of the drawings and specifications.
 2. Certification by the contractor that the material has been properly installed.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American National Standards Institute (ANSI):
 - C80.1-05.....Electrical Rigid Steel Conduit
 - C80.3-05.....Steel Electrical Metal Tubing
- C. National Fire Protection Association (NFPA):
 - 70-08.....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
 - 6-07.....Electrical Rigid Metal Conduit - Steel
 - 50-95.....Enclosures for Electrical Equipment
 - 360-093.....Liquid-Tight Flexible Steel Conduit
 - 467-07.....Grounding and Bonding Equipment
 - 514A-04.....Metallic Outlet Boxes
 - 514B-04.....Conduit, Tubing, and Cable Fittings
 - 797-07.....Electrical Metallic Tubing
- E. National Electrical Manufacturers Association (NEMA):
 - FB1-07.....Fittings, Cast Metal Boxes and Conduit Bodies
for Conduit, Electrical Metallic Tubing and
Cable

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Conduit Size: In accordance with the NEC, but not less than 0.75 in unless otherwise shown.
- B. Conduit:
 1. Rigid steel: Shall conform to UL 6 and ANSI C80.1.
 2. Electrical metallic tubing (EMT): Shall conform to UL 797 and ANSI C80.3. Maximum size not to exceed 4 in and shall be permitted only with cable rated 600 V or less.
- C. Conduit Fittings:
 1. Rigid steel conduit fittings:
 - a. Fittings shall meet the requirements of UL 514B and NEMA FB1.

- b. Standard threaded couplings, locknuts, bushings, conduit bodies, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
 - c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
 - d. Bushings: Metallic insulating type, consisting of an insulating insert, molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
 - e. Sealing fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
3. Electrical metallic tubing fittings:
- a. Fittings and conduit bodies shall meet the requirements of UL 514B, ANSI C80.3, and NEMA FB1.
 - b. Only steel or malleable iron materials are acceptable.
 - c. Compression couplings and connectors: Concrete-tight and rain-tight, with connectors having insulated throats
 - d. Indent-type connectors or couplings are prohibited.
 - e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
- D. Conduit Supports:
- 1. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
 - 2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
 - 3. Multiple conduit (trapeze) hangers: Not less than 1.5 x 1.5 in, 12-gauge steel, cold-formed, lipped channels; with not less than 0.375 in diameter steel hanger rods.
 - 4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.
- E. Outlet, Junction, and Pull Boxes:
- 1. UL-50 and UL-514A.
 - 2. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
 - 3. Sheet metal boxes: Galvanized steel, except where otherwise shown.

4. Flush-mounted wall or ceiling boxes shall be installed with raised covers so that the front face of raised cover is flush with the wall. Surface-mounted wall or ceiling boxes shall be installed with surface-style flat or raised covers.

PART 3 - EXECUTION

3.1 PENETRATIONS

- A. Cutting or Holes:
 1. Cut holes in advance where they should be placed in the structural elements, such as ribs or beams. Obtain the approval of the COTR prior to drilling through structural elements.
 2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammers, impact electric, hand, or manual hammer-type drills are not allowed, except where permitted by the COR as required by limited working space.
- B. Firestop: Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING.
- C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight, as specified in Section 07 92 00, JOINT SEALANTS.

3.2 INSTALLATION, GENERAL

- A. In accordance with UL, NEC, as shown, and as specified herein.
- B. Install conduit as follows:
 1. In complete mechanically and electrically continuous runs before pulling in cables or wires.
 2. Unless otherwise indicated on the drawings or specified herein, installation of all conduits shall be concealed within finished walls, floors, and ceilings.
 3. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
 4. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
 5. Cut square, ream, remove burrs, and draw up tight.
 6. Independently support conduit at 8 ft on centers. Do not use other supports, i.e., suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts.

7. Support within 12 in of changes of direction, and within 12 in of each enclosure to which connected.
 8. Close ends of empty conduit with plugs or caps at the rough-in stage until wires are pulled in, to prevent entry of debris.
 9. Conduit installations under fume and vent hoods are prohibited.
 10. Secure conduits to cabinets, junction boxes, pull-boxes, and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
 11. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.
 12. Conduit bodies shall only be used for changes in direction, and shall not contain splices.
- C. Conduit Bends:
1. Make bends with standard conduit bending machines.
 2. Conduit hickey may be used for slight offsets and for straightening stubbed out conduits.
 3. Bending of conduits with a pipe tee or vise is prohibited.
- D. Layout and Homeruns:
1. Install conduit as shown on drawings.
 2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the COR.

3.3 CONCEALED WORK INSTALLATION

- A. Above Furred or Suspended Ceilings and in Walls:
1. Conduit for conductors: EMT. Mixing different types of conduits indiscriminately in the same system is prohibited.
 2. Align and run conduit parallel or perpendicular to the building lines.
 3. Tightening setscrews with pliers is prohibited.

3.4 EXPOSED WORK INSTALLATION

- A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.
- B. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits indiscriminately in the system is prohibited.
- C. Align and run conduit parallel or perpendicular to the building lines.
- D. Install horizontal runs close to the ceiling or beams and secure with conduit straps.

E. Support horizontal or vertical runs at not over 8 ft intervals.

F. Surface metal raceways: Use only where shown.

3.5 WET OR DAMP LOCATIONS

A. Unless otherwise shown, use conduits of rigid steel or IMC.

B. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant-temperature rooms, air-conditioned spaces, building exterior walls, roofs, or similar spaces.

C. Unless otherwise shown, use rigid steel conduit within 5 ft of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers. Conduit shall be half-lapped with 10 mil PVC tape before installation. After installation, completely recoat or retape any damaged areas of coating.

3.6 CONDUIT SUPPORTS, INSTALLATION

A. Safe working load shall not exceed one-quarter of proof test load of fastening devices.

B. Use pipe straps or individual conduit hangers for supporting individual conduits.

C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 200 lbs. Attach each conduit with U-bolts or other approved fasteners.

D. Support conduit independently of junction boxes, pull-boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.

E. Fasteners and Supports in Solid Masonry and Concrete:

1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.

F. Hollow Masonry: Toggle bolts.

G. Bolts supported only by plaster or gypsum wallboard are not acceptable.

H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.

I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.

J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.

K. Spring steel type supports or fasteners are prohibited for all uses except horizontal and vertical supports/fasteners within walls.

L. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for

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cable and wire with fittings that include internal wedges and retaining collars.

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SECTION 26 05 41
UNDERGROUND ELECTRICAL CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of pullboxes with ducts to form a complete underground raceway system.
- B. "Duct" and "conduit," and "rigid metal conduit" and "rigid steel conduit" are used interchangeably in this specification.

1.2 RELATED WORK

- A. Section 07 92 00, JOINT SEALANTS: Sealing of conduit penetrations.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- C. Section 31 20 00, EARTH MOVING: Trenching, backfill and compaction.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Coordinate layout and installation of ducts, manholes, pullboxes, and pull-boxes with final arrangement of other utilities, site grading, and surface features, as determined in the field.

1.4 SUBMITTALS

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
 - 1. Clearly present sufficient information to determine compliance with drawings and specifications.
 - 2. Include manholes, pullboxes, duct materials, and hardware. Submit plan and elevation drawings, showing openings, pulling irons, cable supports, cover, ladder, sump, and other accessories and details.
 - 3. Proposed deviations from details on the drawings shall be clearly marked on the submittals. If it is necessary to locate manholes or pullboxes at locations other than shown on the drawings, show the proposed locations accurately on scaled site drawings, and submit four copies to the Resident Engineer for approval prior to construction.
- C. Certifications: Two weeks prior to the final inspection, submit four copies of the following certifications to the Resident Engineer:

1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
2. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American Concrete Institute (ACI):
Building Code Requirements for Structural Concrete
318/318M-05.....Building Code Requirements for Structural
Concrete & Commentary
SP-66-04.....ACI Detailing Manual
- C. American National Standards Institute (ANSI):
77-07.....Underground Enclosure Integrity
- D. American Society for Testing and Materials (ASTM):
C858-09.....Underground Precast Concrete Utility Structures
C990-09.....Standard Specification for Joints for Concrete
Pipe, Manholes and Precast Box Sections Using
Preformed Flexible Joint Sealants.
- E. Institute of Electrical and Electronic Engineers (IEEE):
C2-07National Electrical Safety Code
- F. National Electrical Manufacturers Association (NEMA):
TC 2-03.....Electrical Polyvinyl Chloride (PVC) Tubing And
Conduit
TC 3-2004.....PVC Fittings for Use With Rigid PVC Conduit And
Tubing
TC 6 & 8 2003.....PVC Plastic Utilities Duct For Underground
Installations
TC 9-2004.....Fittings For PVC Plastic Utilities Duct For
Underground Installation
- G. National Fire Protection Association (NFPA):
70-08.....National Electrical Code (NEC)
- H. Underwriters Laboratories, Inc. (UL):
6-07.....Electrical Rigid Metal Conduit-Steel
467-07.....Grounding and Bonding Equipment

651-05.....Schedule 40 and 80 Rigid PVC Conduit and
Fittings

651A-00.....Type EB and A Rigid PVC Conduit and HDPE
Conduit

651B-07.....Continuous Length HDPE Conduit

I. U.S. General Services Administration (GSA):

A-A-60005-1998.....Frames, Covers, Gratings, Steps, Sump and Catch
Basin, Manhole

1.6 STORAGE

Lift and support pre-cast concrete structures only at designated
lifting or supporting points.

PART 2 - PRODUCTS

2.1 PULLBOXES

- A. General: Size as indicated on drawings. Provide pullboxes with weatherproof, non-skid covers with recessed hook eyes, secured with corrosion- and tamper-resistant hardware. Cover material shall be identical to pullbox material. Covers shall have molded lettering, ELECTRIC or SIGNAL as applicable. Pullboxes shall comply with the requirements of ANSI/SCTE 77 Tier 8 loading. Provide pulling irons, 0.875 in [22 mm] diameter galvanized steel bar with exposed triangular-shaped opening.
- B. Concrete Pullboxes: Shall be monolithically-poured reinforced concrete.
- C. The wording of pullboxes and handholes shall be used interchangeably on the drawings.

2.2 DUCTS

- A. Number and sizes shall be as shown on drawings.
- B. Ducts (concrete-encased):
 - 1. Plastic Duct:
 - a. UL 651 and 651A Schedule 40 PVC.
 - b. Duct shall be suitable for use with 194° F [90° C] rated conductors.
 - 2. Conduit Spacers: Prefabricated plastic.

2.3 GROUNDING

- A. Rods: Per Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- B. Ground Wire: Stranded bare copper 6 AWG minimum.

2.4 WARNING TAPE

Standard 4-mil polyethylene 3 in [76 mm] wide detectable tape, red with black letters, imprinted with "CAUTION - BURIED ELECTRIC CABLE BELOW" or similar.

2.5 PULL ROPE FOR SPARE DUCTS

Plastic with 200 lb [890 N] minimum tensile strength.

PART 3 - EXECUTION

3.1 PULLBOX INSTALLATION

- A. Assembly and installation shall follow the printed instructions and recommendations of the manufacturer. Install pullboxes level and plumb.
 - 1. Units shall be installed on a 12 in level bed of 90% compacted granular fill, well-graded from the 1 in sieve to the No. 4 sieve. Granular fill shall be compacted with a minimum of four passes with a plate compactor.
 - 2. Seal duct terminations so they are watertight.
- B. Access: Ensure the top of frames and covers are flush with finished grade.

3.2 TRENCHING

- A. Refer to Section 31 20 00, EARTH MOVING for trenching, backfilling, and compaction.
- B. Before performing trenching work at existing facilities, the Ground Penetrating Radar Survey shall be carefully performed by certified technician to reveal all existing underground ducts, conduits, cables, and other utility systems.
- C. Work with extreme care near existing ducts, conduits, cables, and other utilities to avoid damaging them.
- D. Cut the trenches neatly and uniformly.
- E. For Concrete-Encased Ducts:
 - 1. After excavation of the trench, stakes shall be driven in the bottom of the trench at 4 ft intervals to establish the grade and route of the duct bank.
 - 2. Pitch the trenches uniformly toward pullboxes or both ways from high points between pullboxes for the required duct line drainage. Avoid pitching the ducts toward buildings wherever possible.
 - 3. The walls of the trench may be used to form the side walls of the duct bank, provided that the soil is self-supporting and that

concrete envelope can be poured without soil inclusions. Forms are required where the soil is not self-supporting.

4. After the concrete-encased duct has sufficiently cured, the trench shall be backfilled to grade with earth, and appropriate warning tape installed.

F. Conduits to be installed under existing paved areas and roads that cannot be disturbed shall be jacked into place. Conduits shall be heavy wall rigid steel.

3.3 DUCT INSTALLATION

A. General Requirements:

1. Ducts shall be in accordance with the NEC and IEEE C2, as shown on the drawings, and as specified.
2. Slope ducts to drain towards pullboxes, and away from building and equipment entrances. Pitch not less than 4 in per 100 ft.
3. Underground conduit stub-ups and sweeps to equipment inside of buildings shall be taped galvanized rigid steel, and shall extend a minimum of 5 ft outside the building foundation. Tops of conduits below building slab shall be minimum 24 in below bottom of slab.
4. Stub-ups, sweeps, and risers to equipment mounted on outdoor concrete slabs shall be taped galvanized rigid steel, and shall extend a minimum of 5 ft away from the edge of slab.
5. Install insulated grounding bushings on the terminations.
6. Radius for turns of direction shall be sufficient to accomplish pulls without damage. Minimum radius shall be six times conduit diameter. Use manufactured long sweep bends.
7. Additional burial depth shall be required in order to accomplish NEC-required minimum bend radius of ducts.
8. All multiple conduit runs shall have conduit spacers. Spacers shall securely support and maintain uniform spacing of the duct assembly a minimum of 3 in above the bottom of the trench during the concrete pour. Spacer spacing shall not exceed 5 ft. Secure spacers to ducts and earth to prevent floating during concrete pour. Provide nonferrous tie wires to prevent displacement of the ducts during pouring of concrete. Tie wires shall not act as substitute for spacers.
9. Duct lines shall be installed no less than 12 in from other utility systems, such as water, sewer, and chilled water.

10. Clearances between individual ducts:
 - a. For like services, not less than 3 in.
 - b. For power and signal services, not less than 6 in.
 11. Duct lines shall terminate at window openings in pullboxes as shown on the drawings. All ducts shall be fitted with end bells.
 12. Couple the ducts with proper couplings. Stagger couplings in rows and layers to ensure maximum strength and rigidity of the duct bank.
 13. Keep ducts clean of earth, sand, or gravel, and seal with tapered plugs upon completion of each portion of the work.
 14. Seal conduits, including spare conduits, at building entrances and at outdoor equipment terminations with a suitable compound to prevent entrance of moisture and gases.
- B. Concrete-Encased Ducts and Conduits:
1. Install concrete-encased ducts for medium-voltage systems, low-voltage systems, and signal systems, unless otherwise shown on the drawings.
 2. Duct lines shall consist of single or multiple duct assemblies encased in concrete. Ducts shall be uniform in size and material throughout the installation.
 3. Tops of concrete-encased ducts shall be:
 - a. Not less than 24 in and not less than shown on the drawings, below finished grade.
 - b. Not less than 30 in and not less than shown on the drawings, below roads and other paved surfaces.
 - c. Conduits crossing under grade slab construction joints shall be installed a minimum of 4 ft below slab.
 4. Extend the concrete envelope encasing the ducts not less than 3 in beyond the outside walls of the outer ducts and conduits.
 5. Within 10 ft of building manhole and pullbox wall penetrations, install reinforcing steel bars at the top and bottom of each concrete envelope to provide protection against vertical shearing.
 6. Install reinforcing steel bars at the top and bottom of each concrete envelope of all ducts underneath roadways and parking areas.
 7. Where new ducts, conduits, and concrete envelopes are to be joined to existing manholes, pullboxes, ducts, conduits, and concrete

- envelopes, make the joints with the proper fittings and fabricate the concrete envelopes to ensure smooth durable transitions.
8. Conduit joints in concrete may be placed side by side horizontally, but shall be staggered at least 6 in vertically.
 9. Pour each run of concrete envelope between pullboxes or other terminations in one continuous pour. If more than one pour is necessary, terminate each pour in a vertical plane and install 0.75 in reinforcing rod dowels extending 18 in into concrete on both sides of joint near corners of envelope.
 10. Pour concrete so that open spaces are uniformly filled. Do not agitate with power equipment unless approved by Resident Engineer.
 11. Duct Bank Markers:
 - a. Duct bank markers, where required and shown on plans, shall be located at the ends of duct banks except at manholes or pullboxes at approximately every 200 ft along the duct run and at each change in direction of the duct run. Markers shall be placed 2 ft to the right of the duct bank, facing the longitudinal axis of the run in the direction of the electrical load.
 - b. The letter "D" with two arrows shall be impressed or cast on top of the marker. One arrow shall be located below the letter and shall point toward the ducts. The second arrow shall be located adjacent to the letter and shall point in a direction parallel to the ducts. The letter and arrow adjacent to it shall each be approximately 2 in long. The letter and arrows shall be V-shaped, and shall have a width of stroke at least 0.75 in at the top and a depth of 0.25 in.
 - c. In paved areas, the top of the duct markers shall be flush with the finished surface of the paving.
 - d. Where the duct bank changes direction, the arrow located adjacent to the letter shall be cast or impressed with an angle in the arrow equivalent to the angular change of the duct bank.
 - C. Concrete-Encased Duct and Conduit Identification: Place continuous strip of warning tape approximately 12 in above ducts or conduits before backfilling trenches. Warning tape shall be preprinted with proper identification.

- D. Spare Ducts and Conduits: Where spare ducts are shown, they shall have a nylon pull rope installed. They shall be capped at each end and labeled as to location of the other end.
- E. Duct and Conduit Cleaning:
1. Upon completion of the duct installation, a standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material left in the duct. The mandrel shall be not less than 12 in [3600 mm] long, and shall have a diameter not less than 0.5 in [13 mm] less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. The diameter of the brush shall be the same as, or slightly larger than, the diameter of the duct.
- F. Duct and Conduit Sealing: Seal the ducts and conduits at building entrances, and at outdoor terminations for equipment, with a suitable non-hardening compound to prevent the entrance of moisture and gases.
- G. Connections to Pullboxes: Ducts connecting to pullboxes shall be flared to have an enlarged cross-section to provide additional shear strength. Dimensions of the flared cross-section shall be larger than the corresponding manhole opening dimensions by no less than 12 in [300 mm] in each direction. Perimeter of the duct bank opening in the underground structure shall be flared toward the inside or keyed to provide a positive interlock between the duct and the wall of the pullbox. Use vibrators when this portion of the encasement is poured to ensure a seal between the envelope and the wall of the structure.

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**SECTION 312000
EARTH MOVING**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. This section specifies the requirements for furnishing all equipment, materials, labor, tools, and techniques for earthwork including, but not limited to, the following:
1. Site preparation.
 2. Excavation.
 3. Underpinning.
 4. Filling and backfilling.
 5. Grading.
 6. Soil Disposal.
 7. Clean Up.

1.2 DEFINITIONS:

- A. Unsuitable Materials:
1. Fills: Topsoil; frozen materials; construction materials and materials subject to decomposition; clods of clay and stones larger than 75 mm (3 inches); organic material, including silts, which are unstable; and inorganic materials, including silts, too wet to be stable and any material with a liquid limit and plasticity index exceeding 40 and 15 respectively. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction, as defined by ASTM D 1557.
 2. Existing Subgrade (Except Footing Subgrade): Same materials as 1.2.A.1, that are not capable of direct support of slabs, pavement, and similar items with possible exception of improvement by compaction, proofrolling, or similar methods.
 3. Existing Subgrade (Footings Only): Same as paragraph 1, but no fill or backfill. If materials differ from reference borings and design requirements, excavate to acceptable strata subject to Resident Engineer's approval.
- B. Building Earthwork: Earthwork operations required in area enclosed by a line located 1500 mm (5 feet) outside of principal building perimeter.

It also includes earthwork required for auxiliary structures and buildings.

- C. Trench Earthwork: Trenchwork required for utility lines.
- D. Site Earthwork: Earthwork operations required in area outside of a line located 1500 mm (5 feet) outside of principal building perimeter and within new construction area with exceptions noted above.
- E. Degree of compaction: Degree of compaction is expressed as a percentage of maximum density obtained by laboratory test procedure. This percentage of maximum density is obtained through use of data provided from results of field test procedures presented in ASTM D1556, ASTM D2167, and ASTM D2922.
- F. Fill: Satisfactory soil materials used to raise existing grades. In the Construction Documents, the term "fill" means fill or backfill as appropriate.
- G. Backfill: Soil materials or controlled low strength material used to fill an excavation.
- H. Unauthorized excavation: Removal of materials beyond indicated sub-grade elevations or indicated lines and dimensions without written authorization by the Resident Engineer. No payment will be made for unauthorized excavation or remedial work required to correct unauthorized excavation.
- I. Authorized additional excavation: Removal of additional material authorized by the Resident Engineer based on the determination by the Government's soils testing agency that unsuitable bearing materials are encountered at required sub-grade elevations. Removal of unsuitable material and its replacement as directed will be paid on basis of Conditions of the Contract relative to changes in work.
- J. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular sub-base, drainage fill, or topsoil materials.
- K. Structure: Buildings, foundations, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- L. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.
- M. Drainage course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.

Lebanon VA Medical Center
Early Site Prep
Lebanon, PA 17042

May 25, 2012
Issued for Bid
VA Project No 595-12-110
Project No. 3468

- N. Bedding course: Layer placed over the excavated sub-grade in a trench before laying pipe. Bedding course shall extend up to the springline of the pipe.
- O. Sub-base Course: Layer placed between the sub-grade and base course for asphalt paving or layer placed between the sub-grade and a concrete pavement or walk.
- P. Utilities include on-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.
- Q. Debris: Debris includes all materials located within the designated work area not covered in the other definitions and shall include but not be limited to items like vehicles, equipment, appliances, building materials or remains thereof, tires, any solid or liquid chemicals or products stored or found in containers or spilled on the ground.
- R. Contaminated soils: Soil that contains contaminants as defined and determined by the Resident Engineer or the Government's testing agency.

1.3 RELATED WORK:

- A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Safety requirements: Section 00 72 00, GENERAL CONDITIONS, Article, ACCIDENT PREVENTION.
- C. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 01 00 00, GENERAL REQUIREMENTS.
- D. Subsurface Investigation: Section 01 00 00, GENERAL REQUIREMENTS, Article, PHYSICAL DATA.
- E. Erosion Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS, and Section 32 90 00, PLANTING.
- F. Site preparation: Section 31 23 19, DEWATERING, and Section 02 41 00, DEMOLITION.
- G. Paving sub-grade requirements: Section 32 12 16, ASPHALT PAVING.

1.4 CLASSIFICATION OF EXCAVATION:

- A. Unclassified Excavation: Removal and disposal of pavements and other man-made obstructions visible on surface; utilities, and other items including underground structures indicated to be demolished and removed; together with any type of materials regardless of character of material and obstructions encountered.
- B. Rock Excavation:

Lebanon VA Medical Center
Early Site Prep
Lebanon, PA 17042

May 25, 2012
Issued for Bid
VA Project No 595-12-110
Project No. 3468

1. Trenches and Pits: Removal and disposal of solid, homogenous, interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be excavated with a late-model, track-mounted hydraulic excavator; equipped with a 1050 mm (42 inch) wide, short-tip-radius rock bucket; rated at not less than 103 kW (138 hp) flywheel power with bucket-curling force of not less than 125 kN (28,090 lbf) and stick-crowd force of not less than 84.5 kN (19,000 lbf); measured according to SAE J-1179. Trenches in excess of 3000 mm (10 feet) wide and pits in excess of 9000 mm (30 feet) in either length or width are classified as open excavation.
2. Open Excavation: Removal and disposal of solid, homogenous, interlocking crystalline material firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be dislodged and excavated with a late-model, track-mounted loader; rated at not less than 157 kW (210 hp) flywheel power and developing a minimum of 216 kN (48,510 lbf) breakout force; measured according to SAE J-732.
3. Other types of materials classified as rock are unstratified masses, conglomerated deposits and boulders of rock material exceeding 0.76 m³ (1 cubic yard) for open excavation, or 0.57 m³ (3/4 cubic yard) for footing and trench excavation that cannot be removed by rock excavating equipment equivalent to the above in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted.
4. Blasting: Removal and disposal of solid, homogenous, interlocking crystalline material firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be removed with conventional methods may not be performed by blasting.
5. Definitions of rock and guidelines for equipment are presented for general information purposes only. The Contractor is expected to use the information presented in the Geotechnical Engineering Report to evaluate the extent and competency of the rock and to determine both quantity estimations and removal equipment and efforts.

1.5 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Rock Excavation Report:

Lebanon VA Medical Center
Early Site Prep
Lebanon, PA 17042

May 25, 2012
Issued for Bid
VA Project No 595-12-110
Project No. 3468

1. Certification of rock quantities excavated.
2. Excavation method.
3. Labor.
4. Equipment.
5. Land Surveyor's or Civil Engineer's name and official registration stamp.
6. Plot plan showing elevation.

C. Furnish to Resident Engineer:

1. Contactor shall furnish resumes with all personnel involved in the project including Project Manager, Superintendent, and on-site Engineer. Project Manager and Superintendent should have at least 3 years of experience on projects of similar size.
2. Soil samples.
 - a. Classification in accordance with ASTM D2487 for each on-site or borrow soil material proposed for fill, backfill, engineered fill, or structural fill.
 - b. Laboratory compaction curve in accordance with ASTM D 1557 for each on site or borrow soil material proposed for fill, backfill, engineered fill, or structural fill.
 - c. Test reports for compliance with ASTM D 2940 requirements for subbase material.
 - d. Pre-excavation photographs and videotape in the vicinity of the existing structures to document existing site features, including surfaces finishes, cracks, or other structural blemishes that might be misconstrued as damage caused by earthwork operations.
 - e. The Contractor shall submit a scale plan daily that defines the location, limits, and depths of the area excavated.

1.6 APPLICABLE PUBLICATIONS:

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Association of State Highway and Transportation Officials (AASHTO):
T99-01(2004).....Moisture-Density Relations of Soils Using a 2.5 kg (5.5 lb) Rammer and a 305 mm (12 inch) Drop

Lebanon VA Medical Center
Early Site Prep
Lebanon, PA 17042

May 25, 2012
Issued for Bid
VA Project No 595-12-110
Project No. 3468

- T180-01(2004).....Moisture-Density Relations of Soils using a 4.54 kg (10 lb) Rammer and a 457 mm (18 inch) Drop
- C. American Society for Testing and Materials (ASTM):
- D448-03a.....Standard Classification for Sizes of Aggregate for Road and Bridge Construction
- D698-00a1.....Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft. lbf/ft³ (600 kN m/m³))
- D1556-00.....Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
- D1557-02e1.....Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2700 kN m/m³))
- D2167-94 (2001).....Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
- D2487-06.....Standard Classification of Soil for Engineering Purposes (Unified Soil Classification System)
- D2922-05.....Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
- D2940-03.....Standard Specifications for Graded Aggregate Material for Bases or Subbases for Highways or Airports
- D. Society of Automotive Engineers (SAE):
- J732-92.....Specification Definitions - Loaders
- J1179-02.....Hydraulic Excavator and Backhoe Digging Forces

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. General: Provide borrow soil material when sufficient satisfactory soil materials are not available from excavations.
- B. Fills: Material in compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, SC, and ML, or any combination of these groups; free of rock or gravel larger than 75 mm (3 inches) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Material approved from on site or off site sources having a

minimum dry density of 1760 kg/m³ (110 pcf), a maximum Plasticity Index of 15, and a maximum Liquid Limit of 40.

- C. Engineered Fill: Naturally or artificially graded mixture of compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, SC, and ML, or any combination of these groups, or as approved by the Engineer or material with at least 90 percent passing a 37.5-mm (1 1/2-inch) sieve and not more than 12 percent passing a 75-µm (No. 200) sieve, per ASTM D2940;.
- D. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; except with 100 percent passing a 25 mm (1 inch) sieve and not more than 8 percent passing a 75-µm (No. 200) sieve.
- E. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 37.5 mm (1 1/2-inch) sieve and 0 to 5 percent passing a 2.36 mm (No. 8) sieve.
- F. Granular Fill:
 - 1. Under concrete slab, crushed stone or gravel graded from 25 mm (1 inch) to 4.75 mm (No. 4), per ASTM D 2940.
 - 2. Bedding for sanitary and storm sewer pipe, crushed stone or gravel graded from 13 mm (1/2 inch) to 4.75 mm (No 4), per ASTM D 2940.

PART 3 - EXECUTION

3.1 SITE PREPARATION:

- A. Clearing: Clear within limits of earthwork operations as shown. Work includes removal of trees, shrubs, fences, foundations, incidental structures, paving, debris, trash, and other obstructions. Remove materials from Property.
- B. Grubbing: Remove stumps and roots 75 mm (3 inch) and larger diameter. Undisturbed sound stumps, roots up to 75 mm (3 inch) diameter, and nonperishable solid objects a minimum of 900 mm (3 feet) below subgrade or finished embankment may be left.
- C. Trees and Shrubs: Trees and shrubs, not shown for removal, may be removed from areas within 4500 mm (15 feet) of new construction and 2250 mm (7.5 feet) of utility lines when removal is approved in advance by Resident Engineer. Remove materials from Property. Box, and otherwise protect from damage, existing trees and shrubs which are not shown to be

removed in construction area. Immediately repair damage to existing trees and shrubs by trimming, cleaning and painting damaged areas, including roots, in accordance with standard industry horticultural practice for the geographic area and plant species. Do not store building materials closer to trees and shrubs, that are to remain, than farthest extension of their limbs.

- D. Stripping Topsoil: Strip topsoil from within limits of earthwork operations as specified. Topsoil shall be a fertile, friable, natural topsoil of loamy character and characteristic of locality. Topsoil shall be capable of growing healthy horticultural crops of grasses. Stockpile topsoil and protect as directed by Resident Engineer. Eliminate foreign materials, such as weeds, roots, stones, subsoil, frozen clods, and similar foreign materials larger than 0.014 m³ (1/2 cubic foot) in volume, from soil as it is stockpiled. Retain topsoil on station. Remove foreign materials larger than 50 mm (2 inches) in any dimension from topsoil used in final grading. Topsoil work, such as stripping, stockpiling, and similar topsoil work shall not, under any circumstances, be carried out when soil is wet so that the composition of the soil will be destroyed.
- E. Concrete Slabs and Paving: Score deeply or saw cut to insure a neat, straight cut, sections of existing concrete slabs and paving to be removed where excavation or trenching occurs. Extend pavement section to be removed a minimum of 300 mm (12 inches) on each side of widest part of trench excavation and insure final score lines are approximately parallel unless otherwise indicated. Remove material from Property.
- F. Lines and Grades: Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 00, GENERAL REQUIREMENTS, shall establish lines and grades.
1. Grades shall conform to elevations indicated on plans within the tolerances herein specified. Generally grades shall be established to provide a smooth surface, free from irregular surface changes. Grading shall comply with compaction requirements and grade cross sections, lines, and elevations indicated. Where spot grades are indicated the grade shall be established based on interpolation of the elevations between the spot grades while maintaining appropriate transition at structures and paving and uninterrupted drainage flow into inlets.

Lebanon VA Medical Center
Early Site Prep
Lebanon, PA 17042

May 25, 2012
Issued for Bid
VA Project No 595-12-110
Project No. 3468

2. Locations of existing and proposed elevations indicated on plans are approximate. Proposed spot elevations and contour lines have been developed utilizing the existing conditions survey and developed contour lines and may be approximate. Contractor is responsible to notify Resident Engineer of any differences between existing elevations shown on plans and those encountered on site by Surveyor/Engineer described above. Notify Resident Engineer of any differences between existing or constructed grades, as compared to those shown on the plans.
 3. Subsequent to establishment of lines and grades, Contractor will be responsible for any additional cut and/or fill required to ensure that site is graded to conform to elevations indicated on plans.
 4. Finish grading is specified in Section 32 90 00, PLANTING.
- G. Disposal: All materials removed from the property shall be disposed of at a legally approved site, for the specific materials, and all removals shall be in accordance with all applicable Federal, State and local regulations. No burning of materials is permitted onsite.

3.2 EXCAVATION:

- A. Shoring, Sheet piling and Bracing: Shore, brace, or slope, its angle of repose or to an angle considered acceptable by the Resident Engineer, banks of excavations to protect workmen, banks, adjacent paving, structures, and utilities.
1. Design of the temporary support of excavation system is the responsibility of the Contractor.
 2. Construction of the support of excavation system shall not interfere with the permanent structure and may begin only after a review by the Resident Engineer.
 3. Extend shoring and bracing to a minimum of 1500 mm (5 feet) below the bottom of excavation. Shore excavations that are carried below elevations of adjacent existing foundations.
 4. If bearing material of any foundation is disturbed by excavating, improper shoring or removal of existing or temporary shoring, placing of backfill, and similar operations, the Contractor shall underpin the existing foundation, per Section 3.3 under disturbed foundations, as directed by Resident Engineer, at no additional cost

to the Government. Do not remove shoring until permanent work in excavation has been inspected and approved by Resident Engineer.

- B. Excavation Drainage: Operate pumping equipment, and/or provide other materials, means and equipment as required to keep excavation free of water and subgrade dry, firm, and undisturbed until approval of permanent work has been received from Resident Engineer. Approval by the Resident Engineer is also required before placement of the permanent work on all subgrades.
- C. Subgrade Protection: Protect subgrades from softening, undermining, washout, or damage by rain or water accumulation. Reroute surface water runoff from excavated areas and not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches. When subgrade for foundations has been disturbed by water, remove disturbed material to firm undisturbed material after water is brought under control. Replace disturbed subgrade in trenches with concrete or material approved by the Resident Engineer.
- D. Proofrolling:
 - 1. After rough grade has been established in cut areas and prior to placement of fill in fill areas under building and pavements, proofroll exposed subgrade with a fully loaded dump truck to check for pockets of soft material.
 - 2. Proofrolling shall consist of at least two complete passes with one pass being in a direction perpendicular to preceding one. Remove any areas that deflect, rut, or pump excessively during proofrolling, or that fail to consolidate after successive passes to suitable soils and replaced with compacted fill. Maintain subgrade until succeeding operation has been accomplished.
- E. Building Earthwork:
 - 1. Excavation shall be accomplished as required by drawings and specifications.
 - 2. Excavate foundation excavations to solid undisturbed subgrade.
 - 3. Remove loose or soft materials to a solid bottom.
 - 4. Fill excess cut under footings or foundations with 25 MPa (3000 psi) concrete poured separately from the footings.
 - 5. Do not tamp earth for backfilling in footing bottoms, except as specified.

Lebanon VA Medical Center
Early Site Prep
Lebanon, PA 17042

May 25, 2012
Issued for Bid
VA Project No 595-12-110
Project No. 3468

6. Slope grades to direct water away from excavations and to prevent ponding.

F. Trench Earthwork:

1. Utility trenches (except sanitary and storm sewer):

- a. Excavate to a width as necessary for sheeting and bracing and proper performance of the work.
- b. Grade bottom of trenches with bell holes scooped out to provide a uniform bearing.
- c. Support piping on undisturbed earth unless a mechanical support is shown.
- d. Length of open trench in advance of piping laying shall not be greater than is authorized by Resident Engineer.

2. Sanitary and storm sewer trenches:

- a. Trench width below a point 150 mm (6 inches) above top of pipe shall be 600 mm (24 inches) maximum for pipe up to and including 300 mm (12 inches) diameter, and four-thirds diameter of pipe plus 200 mm (8 inches) for pipe larger than 300 mm (12 inches). Width of trench above that level shall be as necessary for sheeting and bracing and proper performance of the work.
- b. Bed bottom quadrant of pipe on undisturbed soil or granular fill.
 - 1) Undisturbed: Bell holes shall be no larger than necessary for jointing. Backfill up to a point 300 mm (12 inches) above top of pipe shall be clean earth placed and tamped by hand.
 - 2) Granular Fill: Depth of fill shall be a minimum of 75 mm (3 inches) plus one sixth of pipe diameter below pipe to 300 mm (12 inches) above top of pipe. Place and tamp fill material by hand.
- c. Place and compact as specified remainder of backfill using acceptable excavated materials. Do not use unsuitable materials.
- d. Use granular fill for bedding where rock or rocky materials are excavated.

- G. Site Earthwork: Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation. Excavation shall be accomplished as required by drawings and specifications. Excavate to indicated elevations and dimensions within a

tolerance of plus or minus 25 mm (1 inch). Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, complying with OSHA requirements, and for inspections. Remove subgrade materials that are determined by Resident Engineer as unsuitable, and replace with acceptable material. If there is a question as to whether material is unsuitable or not, the contractor shall obtain samples of the material, under the direction of the Resident Engineer, and the materials shall be examined by an independent testing laboratory for soil classification to determine whether it is unsuitable or not. When unsuitable material is encountered and removed, contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable. Adjustments to be based on volume in cut section only.

1. Site Grading:

- a. Provide a smooth transition between adjacent existing grades and new grades.
- b. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- c. Slope grades to direct water away from buildings and to prevent ponds from forming where not designed. Finish subgrades to required elevations within the following tolerances:
 - 1) Lawn or Unpaved Areas: Plus or minus 25 mm (1 inch).
 - 2) Walks: Plus or minus 25 mm (1 inch).
 - 3) Pavements: Plus or minus 13 mm (1 inch).
- d. Grading Inside Building Lines: Finish subgrade to a tolerance of 13 mm (1/2 inch) when tested with a 3000 mm (10 foot) straightedge.

3.3 UNDERPINNING:

- A. Design of the underpinning system is the responsibility of the Contractor and is subject to review and approval by the Resident Engineer. Underpinning of existing building foundations, as indicated on structural drawings, or where excavation undermines existing foundations, shall be accomplished in the following manner:

1. Make general excavation for new construction, where new foundations are to be below existing foundations, to elevation of new foundations (or sized stone subbase), maintaining a 45 degree sloped berm.
2. For underpinning pits, underpin existing wall foundations by excavating 1200 mm (4 feet) wide pits to depth shown on drawings skipping 3 sections at any one time so as to maintain support for wall at all times.
3. Underpin intervening sections one at a time; no adjacent sections shall be underpinned until concrete in adjacent sections shall have reached 20 MPa (2500 psi) strength and have been dry packed with non-shrink grout to obtain positive bearing. Sheet and brace underpinning pits if soil will not stand on a vertical cut during this operation, or as required for safety of workmen. Repack any voids behind sheeting to prevent sloughing which could cause settlement of existing foundations. Contractor performing this portion of work shall have been prequalified by Resident Engineer as having previously performed successfully this type of work or will demonstrate his capability for successfully performing this work. It shall be sole responsibility of the Contractor to guard against objectionable movement or settlement and to preserve integrity of existing structures.
4. The tip elevation of the underpinning pits shall be a minimum of 900 mm (3 feet) below the adjacent excavation elevation.
5. Subgrades at the tip of the underpinning pit shall be clean, dry, and free of debris and shall be observed by the Resident Engineer prior to concrete placement.
6. Concrete shall not be free fall greater than 3000 mm (10 feet) into the pit.

3.4 FILLING AND BACKFILLING:

- A. General: Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from excavation. For fill and backfill, use excavated materials and borrow meeting the criteria specified herein, as applicable. Borrow will be supplied at no additional cost to the Government. Do not use unsuitable excavated materials. Do not backfill until foundation walls have been completed above grade and adequately braced, waterproofing or

dampproofing applied, foundation drainage, and pipes coming in contact with backfill have been installed and work inspected and approved by Resident Engineer.

- B. Placing: Place materials in horizontal layers not exceeding 200 mm (8 inches) in loose depth for material compacted by heavy compaction equipment, and not more than 100 mm (4 inches) in loose depth for material compacted by hand-operated tampers and then compacted. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure. Place no material on surfaces that are muddy, frozen, or contain frost.
- C. Compaction: Compact with approved tamping rollers, sheepsfoot rollers, pneumatic tired rollers, steel wheeled rollers, vibrator compactors, or other approved equipment (hand or mechanized) well suited to soil being compacted. Do not operate mechanized vibratory compaction equipment within 3000 mm (10 feet) of new or existing building walls without prior approval of Resident Engineer. Moisten or aerate material as necessary to provide moisture content that will readily facilitate obtaining specified compaction with equipment used. Compact soil to not less than the following percentages of maximum dry density, according to ASTM D698 or ASTM D1557 as specified below:
 - 1. Fills, Embankments, and Backfill
 - a. Under proposed structures, building slabs, steps, and paved areas, scarify and recompact top 300 mm (12 inches) of existing subgrade and each layer of backfill or fill material in accordance with ASTM D1557, D 1556, D 2167, D 2922; 95 percent.
 - b. Curbs, curbs and gutters, ASTM D1557, D 1556, D 2167, D 2922; 95 percent.
 - c. Under Sidewalks, scarify and recompact top 150 mm (6 inches) below subgrade and compact each layer of backfill or fill material in accordance with ASTM D1557, D 1556, D 2167, D 2922; 95 percent.
 - d. Landscaped areas, top 400 mm (16 inches), ASTM D1557, D 1556, D 2167, D 2922; 85 percent.
 - e. Landscaped areas, below 400 mm (16 inches) of finished grade, ASTM D1557, D 1556, D 2167, D 2922; 90 percent.
 - 2. Natural Ground (Cut or Existing)

Lebanon VA Medical Center
Early Site Prep
Lebanon, PA 17042

May 25, 2012
Issued for Bid
VA Project No 595-12-110
Project No. 3468

- a. Under building slabs, steps and paved areas, top 150 mm (6 inches), ASTM D1557, D 1556, D 2167, D 2922; 95 percent.
- b. Curbs, curbs and gutters, top 150 mm (6 inches), ASTM D1557, D 1556, D 2167, D 2922; 95 percent.
- c. Under sidewalks, top 150 mm (6 inches), ASTM D1557, D 1556, D 2167, D 2922; 95 percent.

3.5 GRADING:

- A. General: Uniformly grade the areas within the limits of this section, including adjacent transition areas. Smooth the finished surface within specified tolerance. Provide uniform levels or slopes between points where elevations are indicated, or between such points and existing finished grades. Provide a smooth transition between abrupt changes in slope.
- B. Cut rough or sloping rock to level beds for foundations. In pipe spaces or other unfinished areas, fill low spots and level off with coarse sand or fine gravel.
- C. Slope backfill outside building away from building walls for a minimum distance of 1800 mm (6 feet).
- D. Finish grade earth floors in pipe basements as shown to a level, uniform slope and leave clean.
- E. Finished grade shall be at least 150 mm (6 inches) below bottom line of window or other building wall openings unless greater depth is shown.
- F. Place crushed stone or gravel fill under concrete slabs on grade, tamped, and leveled. Thickness of fill shall be 150 mm (6 inches) unless otherwise shown.
- G. Finish subgrade in a condition acceptable to Resident Engineer at least one day in advance of paving operations. Maintain finished subgrade in a smooth and compacted condition until succeeding operation has been accomplished. Scarify, compact, and grade subgrade prior to further construction when approved compacted subgrade is disturbed by Contractor's subsequent operations or adverse weather.
- H. Grading for Paved Areas: Provide final grades for both subgrade and base course to +/- 6 mm (0.25 inches) of indicated grades.

Lebanon VA Medical Center
Early Site Prep
Lebanon, PA 17042

May 25, 2012
Issued for Bid
VA Project No 595-12-110
Project No. 3468

3.6 DISPOSAL OF UNSUITABLE AND EXCESS EXCAVATED MATERIAL:

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off // Medical Center // Cemetery // property.
- B. Remove from site and dispose of any excess excavated materials after all fill and backfill operations have been completed.

3.7 CLEAN UP:

Upon completion of earthwork operations, clean areas within contract limits, remove tools, and equipment. Provide site clear, clean, free of debris, and suitable for subsequent construction operations. Remove all debris, rubbish, and excess material from Property.

----- E N D -----